MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, SESSION 2018/2019

EEL4126 – POWER SYSTEM OPERATION AND CONTROL

(LE)

29 MAY 2019
9:00 AM – 11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question Paper consists of 3 pages including the cover page with FOUR Questions only.

2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) List four constraints in Unit Commitment related problems in power system. [2 marks]

(b) The following are data pertaining to three generators in a power plant.

Unit	Cost Characteristic (RM/Hr)	Max. Power (MW)	Min. Power (MW)
1	$C_1 = 5610 + 79.2P_1 + 0.01562P_1^2$	600	150
2	$C_2 = 3100 + 78.5P_2 + 0.0194P_2^2$	400	100
3	$C_3 = 936 + 95.64P_3 + 0.05784P_3^2$	200	50

Which unit or what is the combination of units should be used in order to supply a load of 550 MW most economically? [23 Marks]

[Hint: There will be 2^n possible combination, where n = number of generators in the plant.]

Question 2

(a) Security constrained optimal power flow could be divided into FOUR categories. Name and explain each of them with aid of figures. [10 Marks]

(b) Figure Q2 shows a 3-bus power system. The per unit (p.u.) values for the system is as shown in Table Q2. The system has the line reactances of $x_{12} = 0.2$ p.u., $x_{13} = 0.3$ p.u., and $x_{23} = 0.4$ p.u..

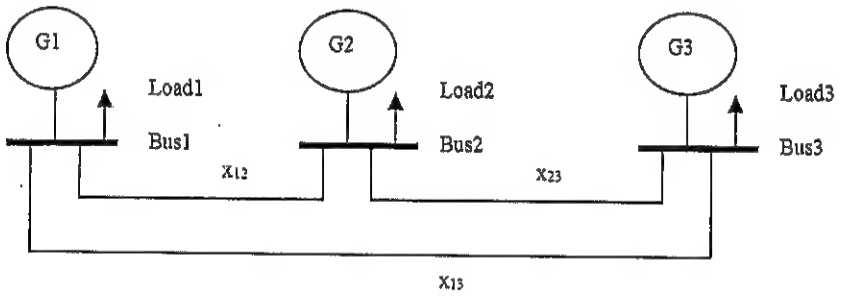

Figure Q2

Table Q2

Bus	Load (pu)	Gen. (pu)
1	1.2	1.5
2	2.8	1.8
3	1.0	1.7 (reference)

(i) Find the [3x3] bus admittance matrix, B and hence determine the base power flows on the transmission lines. [9 Marks]

(ii) Determine the generation shift factors for all lines for a change in Generator 1 (G1). [3 Marks]

(iii) Compute the line outage distribution factor for line 2 – 3 for an outage of line 1 – 2 and the power flow in line 2-3 after the outage. [3 Marks]

Continued...

Question 3

(a) Two generators G_1 and G_2, with power rating of 200 MW and 400MW, respectively are supplying power to a network. Both the generators are loaded at 50% of their individual full rated capacity and operated at the system frequency of 50 Hz. What is the speed droop of generator G_1 and G_2 if the load on the system decreases by 150 MW and the frequency rises by 0.5 Hz? [5 Marks]

(b) In power system network, tie-line is the transmission line that connecting two areas of the power system. The system is operating at 60 Hz. System capacity of Area 1 is 1000 MVA with speed drop, R_1 of 0.02 p.u and the load characteristic, D_1 equal to 1.0 p.u. ; whereas the system capacity for Area 2 is 500 MVA with the speed droop and load characteristic of $R_2 = 0.01$ p.u. and $D_2 = 0.8$ p.u., respectively.

(i) Draw the block diagram of an interconnected two-area system where the tie flow was defined as going from area 1 to area 2. [8 Marks]

(ii) If a sudden increase of 100 MW load occurs in Area 1, find the following:
- new steady state frequency,
- change in tie-line power flow,
- changes in prime mover powers, and hence
- comment on the total change in generation.

[12 Marks]

Question 4

(a) With a neat sketch, explain the brushless excitation scheme for an alternator. [18 Marks]

(b) The AVR system of an alternator has the following parameters.

	Amplifier	Exciter	Alternator	Sensor
Gain	9	1	1	1
Time constant	0.18	0.4	1.0	0.05

(i) Draw the AVR block diagram. [3 Marks]
(ii) Compute the closed loop transfer function. [3 Marks]
(iii) Calculate the steady state error of the AVR for a step input. [1 Mark]

End of Paper.